Remarks

Claims 1 – 18 are pending in the application. Claim 18 has been withdrawn from further consideration pursuant to 37 C.F.R. 1.142(b) as being drawn to a non-elected invention. Claims 1 – 17 have been elected for continued examination. Claims 1 – 17 stand rejected under 35 U.S.C. §112 first and second paragraphs, and 35 U.S.C. §103(a).

Claim Rejections – 35 USC §112

Claim 1 has been rejected under 35 U.S.C. 112, first paragraph as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or which it is most nearly connected, to make and/or use the invention. In particular, the Examiner asserts that Claim 1 does not provide disclosure of the "way" of adjusting variation profiles to lead to the production of materials.

Claim 1 has been amended to delete the aforesaid way of adjusting variation profiles and include controlling a set of temperatures, controlling the temporal variation of the set of temperatures, and controlling process parameters in a reaction chamber. The control of the set of temperatures, the temporal variation thereof and process parameters in a reaction chamber is supported at page 3, line 8 through page 4, line 7 and page 6. line 3 through page 8, line 3 of the Specification as filed.

Claims 1 - 17 have been rejected under 35 U.S.C. 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention.

The phrase "said heating system T_8" has been deleted from Claim 1.

The phrase "a controller that controls or controls in a closed loop, respectively, the type or the composition of the in-flowing process gases and the temperature of the wafer" has been deleted from Claim 1. In order to clarify what the controller controls, Claim 1 has been amended to include the recitation of "a controller for controlling the process gases and a set of temperatures and variations thereof characteristic of the reaction chamber."

The phrase "and particularly of strata on wafers" in Claim 1 has been reworded as "in the nature of strata on a wafer".

In the phrase "possibly a gas mixing system", the word "possibly" has been deleted from Claim 1.

In Claim 1, the phrase "are adjusted with temperature variation profiles within the range of seconds in such a way that the variation of the process parameters so caused results in a dynamic control of the thermal processes leading to the production of the materials" has been deleted.

With regard to the phrase "dynamic control" in Claim 1, the phrase "the variation of the process parameters so caused results in a dynamic control of the thermal processes leading to the production of the materials" has been deleted from Claim 1.

With regard to the use of "e.g" in Claim 1, the phrase "said reaction chamber, e.g. the gas" has been deleted from Clam 1.

With regard to the use of the phrase "a controller that controls or controls in a closed loop", in Claim 1, to clarify the controller, Claim 1 has been amended to recite "a controller for controlling the process gases and a set of temperatures and variations thereof characteristic of the reaction chamber."

With regard to the use of the phrase "for avoiding the formation of addition compounds", in Claim 2, Claim 2 has been amended to delete the phrase "and by adjustment of the temperature for avoiding the formation of addition compounds."

With regard to the use of the phrase "required reproducible temperature variations of up to 250 °C per minute", in Claim 4, Claim 4 has been amended to delete the phrase "and up to 1600 °C, with required reproducible temperature variations of up to 250 °C per minute."

With regard to the use of the term "correlate" in Claim 5, Claim 5 has been amended to delete the phrase "as a correlate to" and include the recitation of "wherein controlling the set of process temperatures comprises controlling the temperature of the second wafer support, T_4, in correspondence with the temperature of the first wafer support, T_3."

In addition, Claim 8 has been amended to delete the phrase "and to correlate" and recite "wherein controlling the set of process temperatures comprises controlling the temperature of the upper side of the reaction chamber, T_7, as a constant temperature in correspondence with the temperature of the first wafer support, T_3."

Furthermore, Claim 9 has been amended to delete the phrase "and to correlate" and recite "wherein controlling the set of process temperatures comprises controlling the temperature of the heating system, T_8, as a constant temperature in correspondence with the temperature of the first wafer support, T_3."

Claim Rejections – 35 USC §103

Claims 1 – 10 and 12 – 17 stand rejected under 35 U.S.C. § 103 as being unpatentable over Schmitz et al ("MOVPE growth of InGaN on sapphire using growth initiation cycles" Materials Science & Engineering B, 1997) in view of Burmeister (U.S. Patent 3,617,371).

The present invention is directed to a method of producing nitrogenous semiconductor crystal materials in the nature of strata on a wafer of the form $A_XB_YC_ZN_VM_W$. A, B and C represent elements of elemental group II or group III, N represents nitrogen, M represents an element of elemental group V or group VI, and X, Y, Z, V and W represent the mol fraction of each element in $A_XB_YC_ZN_VM_W$. Production of the semiconductor crystal materials takes place in a reactor comprising a reaction chamber defined by a set of chamber walls and an upper side and lower side. A first wafer support is positioned within the reaction chamber. A gas inlet through which process gases flow into the reaction chamber is provided. A gas mixing system is in fluid communication with the reaction chamber. A gas outlet through which the process gases are discharged from the reaction chamber is also provided. A second wafer support is positioned on the first wafer support. A heating system heats the first wafer support. A controller controls the process gases and a set of process temperatures and variations thereof characteristic of the reaction chamber.

The method comprises controlling the set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8.

The method also includes controlling the temporal variation of the set of process temperatures and controlling process parameters in the reaction chamber.

Schmitz et al ("MOVPE growth of InGaN on sapphire using growth initiation cycles" Materials Science & Engineering B, 1997) discloses that an inductive heater grings a susceptor to a maximum temperature of 1600 degrees C and that due to the small

thermal mass of the susceptor, very fast heat-up and cooling cycles up to 6 degrees per second can be achieved. (*Col. 2 – 3*). Furthermore Schmitz reveals that growth temperatures are adjusted with a preceision of 0.1 degree C at the required value between 450 and 1050 degrees C. Precise temperature control of a quartz ceiling inside a reactor is employed to keep only a remaining inner reactor wall at a suitable elevated temperature (700 – 950 degrees C). (*Col. 4 – 5*).

However, Schmitz et al ("MOVPE growth of InGaN on sapphire using growth initiation cycles" Materials Science & Engineering B, 1997) fails to teach or even suggest controlling a set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8; controlling the temporal variation of the set of process temperatures; and controlling process parameters in the reaction chamber as required by amended Claim 1.

Burmeister (U.S. Patent 3,617,371) discloses a vertical reactor which includes separately arranged source, mixing and growing chambers which may be selectively heated inductively to eliminate contaminating decomposition of the reactor walls. (*Col. 1, l. 25 – 28*). Cylindrical walls enclose the chambers and comprise an electrically conductive refractory material such as graphite. These conductive walls are electromagnetically coupled to RF heating coils which in turn are coupled to a source of RF power. An upper portion adjacent the source chamber operates at approximately 850 degrees C, a portion adjacent the mixing chamber operates at approximately 800 degrees C and a lower portion adjacent the growing chamber operates at approximately 750 degrees C. (*Col. 2, l. 30 – 54*).

However, Burmeister (U.S. Patent 3,617,371) fails to teach or even suggest controlling a set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8; controlling the temporal variation of the set of process temperatures; and controlling process parameters in the reaction chamber as required by amended Claim 1.

Thus, Schmitz et al. and Burmeister fail to teach or even suggest, either alone or in combination, all elements of Claim 1, namely controlling a set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8; controlling the temporal variation of the set of process temperatures; and controlling process parameters in the reaction chamber.

Therefore, the Applicants respectfully submit that Claim 1 as amended is clearly patentable over Schmitz et al. in view of Burmeister and stands in condition for allowance. Claims 2 – 10 and 12 – 17, which depend variously from Claim 1 are therefore also patentable for at least the same reasons as set forth with respect to Claim 1.

Takai et al. (U.S. Patent 5,402,748) discloses a GaAs layer grown directly on a silicon substrate at a low temperature of 350 – 400 degrees C while supplying TMG and AsH_3 together with H_2.

However, Takai et al. (U.S. patent 5,402,748) fails to teach or even suggest controlling a set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8; controlling the temporal variation of the set of process temperatures; and controlling process parameters in the reaction chamber as required by amended Claim 11, dependent from Claim 1.

Thus, Schmitz et al., Burmeister and Takai et al. fail to teach or even suggest, either alone or in combination, all elements of Claim 11, namely controlling a set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8; controlling the temporal variation of the set of process temperatures; and controlling process parameters in the reaction chamber.

Therefore, the Applicants respectfully submit that Claim 11 as amended is clearly patentable over Schmitz et al. and Burmeister further in view of Takai et al. and stands in condition for allowance.

Conclusion

Thus, based upon the foregoing Amendments and Remarks, the Applicants submit that Claims 1 – 17 are patentable over Schmitz et al. and Burmeister and further in

view of Takai et al. and stand in condition for allowance. Notification of that fact is earnestly sought.

Respectfully submitted,

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A Clean Version of Amended Claims 1 – 17 is Submitted Herewith:

1. (Amended) A method of producing nitrogenous semiconductor crystal materials in the nature of strata on a wafer of the form $A_XB_YC_ZN_VM_W$, wherein A, B and C represent elements of elemental group II or group III, N represents nitrogen, M represents an element of elemental group V or group VI, and X, Y, Z, V and W represent the mol fraction of each element in $A_XB_YC_ZN_VM_W$, in a reactor comprising a reaction chamber defined by a set of chamber walls and an upper side and lower side thereof, a first wafer support positioned within the reaction chamber, a gas inlet through which process gases flow into the reaction chamber, a gas mixing system in fluid communication with the reaction chamber, a gas outlet through which the process gases are discharged from the reaction chamber, a second wafer support positioned on the first wafer support, a heating system for heating the first wafer support, and a controller for controlling the process gases and a set of process temperatures and variations thereof characteristic of the reaction chamber; the method comprising:

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controlling the set of process temperatures wherein the set of process temperatures is selected from the group consisting of the temperature of the gas inlet, T_1, the temperature of the chamber walls, T_2, the temperature of the first wafer support, T_3, the temperature of the second wafer support, T_4, the temperature of the gas outlet, T_5, the temperature of the gas mixing system, T_6, the temperature of the upper side of the reaction chamber, T_7, and the temperature of the heating system, T_8;

controlling the temporal variation of the set of process temperatures; and

controlling process parameters in the reaction chamber.

2. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the gas inlet, T_1, so as to be below a condensation temperature of the process gases.--

3. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the chamber walls, T_2, so as to be equal to the temperature of the first wafer support, T_3.

4. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the first wafer support, T_3, as a constant temperature.

5. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the second wafer support, T_4, in correspondence with the temperature of the first wafer support, T_3.

6. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the gas outlet, T_5, to a value smaller than the value of the temperature of the second wafer support, T_4, and the temperature the first wafer support, T_3.

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7. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the gas mixing system, T_6, as a constant temperature smaller than the temperature of the gas inlet, T_1.--

8. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the upper side of the reaction chamber, T_7, as a constant temperature in correspondence with the temperature of the first wafer support, T_3.

9. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling the temperature of the heating system, T_8,

as a constant temperature in correspondence with the temperature of the first wafer support, T_3.

10. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling a temperature-dependent gas flow variation.

11. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling a temperature-dependent total pressure variation in the reaction chamber.

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12. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling a temperature-dependent principal carrier gas variation in the reaction chamber.

13. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises controlling temperature-dependent interrupts in the production process.

14. (Amended) The method according to Claim 1 further comprising applying the semiconductor materials to be produced on a mechanical carrier of a semiconductor of group IV, a semiconductor of groups III-V, oxides or any other material resistant to temperatures and the process gases.

15. (Amended) The method according to Claim 14 further comprising pre-treating said mechanical carrier by applying lines, dots, or by carrying out other steps for surface treatment, or by partially covering the surface with other materials or material components.

16. (Amended) The method according to Claim 1 further comprising a two-stage application of pre-processed $A_XB_YC_ZN_VM_W$ materials.

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17. (Amended) The method according to Claim 1 wherein controlling the set of process temperatures comprises employing a temperature-controlled injector.--